1. *Fundamentals: Stationarity and invertibility, 16.12.2015.* Decide whether the process

$$x_t = 3 + 1.5x_{t-1} - 1.2x_{t-2} + u_t - 1.3u_{t-1} - 0.2u_{t-2} + 0.2u_{t-3}$$

   is stationary and invertible

   For each of these properties write:

   - *(1 point for each property)* polynomial, the roots of which you compute and the number of roots
   - *(1 point for each property)* absolute values of these roots
   - *(1 point for each property)* conclusion - if the process is stationary and invertble

2. The same for the processes:

   - (sample exam, 2015) $x_t = 2 + 1.2x_{t-1} - 1.1x_{t-2} + 0.7x_{t-3} + u_t - 1.3u_{t-1} + 1.2u_{t-2}$
   - (16.12.2015, second exam) $x_t = 5 + 1.2x_{t-1} + u_t + 1.8u_{t-1} + 0.25u_{t-2} + 0.9u_{t-3}$
   - (8.1.2016) $x_t = 5 + 1.2x_{t-1} - 0.8x_{t-2} + 0.1x_{t-3} + u_t + 1.8u_{t-1}$

3. *Fundamentals: ARIMA modelling, 16.12.2015* Load the data:

```
library(astsa); y <- ts(fmri$L1T5[,3])
```

   (a) Test the hypothesis about the unit root. Write:
      - *(1 point)* type of the test which you used and the reason for this choice
      - *(2 points)* estimated regression (based on the output from R, not a general case),
      - *(2 points)* hypothesis about the coefficients which is tested and derivation, why it corresponds to a unit root
      - *(1 point)* conclusion - is there a unit root or not, and what are the consequences of this result for the modelling

   (b) *(6 points)* Find a suitable model for the dat. Write only which ARIMA(p,d,q) model it is (i.e., specify p, d, q). Requirements: correct order of differencing, stationarity, invertibility, residuals

   (c) *(2 points)*Write down the polynomials which we need to check when checking stationarity and invertibility. What condition has to be satisfied?

4. The same for the data

   - (sample exam, 2015) `library(astsa); y <- ts(fmri$L1T1[,1])`
   - (16.12.2015, second exam) `library(astsa); y <- ts(fmri$L9T1[1:90,3])`
   - (8.1.2016) `library(astsa); y <- ts(fmri$L9T1[10:100,2])`